PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 41

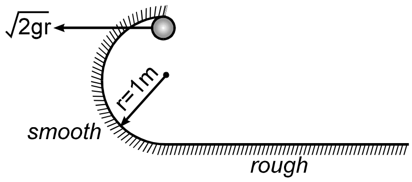
Total Marks : 31

Max. Time : 31 min.

Topics : Work, Power and Energy, Circular Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Multiple choice objective ('–1' negative marking) Q.7	(4 marks, 4 min.)	[4, 4]
Comprehension ('–1' negative marking) Q.8 to Q.10	(3 marks, 3 min.)	[9, 9]

1. A body is given a velocity $\sqrt{2gr}$ at the highest point of a half circular smooth track which is joined by a rough horizontal track whose co-efficient of friction is μ = 0.5. Then the distance travelled by particle before it stops on horizontal track is: (r = 1 m)

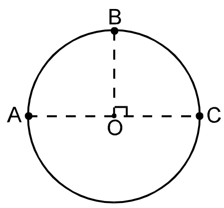


(A) 1 m (B) 4 m (C) 6 m (D) none of these

2. A particle moves along a circle of radius R with a constant angular speed ω .Its displacement (only magnitude) in time t will be

(A) ωt (B) 2 R cos ωt (C) 2 R sin ωt (D) 2R sin $\frac{\omega t}{2}$

3. Three particle A, B & C move in a circle of radius r = $\frac{1}{\pi}$ m, in anticlockwise direction with speeds 1 m/s, 2.5 m/s and 2 m/s respectively. The initial positions of A, B and C are as shown in figure. The ratio of distance travelled by B and C by the instant A, B and C meet for the first time is



(A) 3 : 2 (B) 5 : 4 (C) 3 : 5 (D) 3 : 7

4. Two bodies having masses 10 kg and 5 kg are moving in concentric orbits of radii 4 and 8 such that their time periods are the same. Then the ratio of their centripetal accelerations is

(A) $\frac{1}{2}$ (B) 2 (C) 8 (D) $\frac{1}{8}$

5. A stone is thrown horizontally under gravity with a speed of 10m/sec. Find the radius of curvature of it's trajectory at the end of 3 sec after motion began.

(A) $10\sqrt{10}$ m (B) $100\sqrt{10}$ m (C) $\sqrt{10}$ m (D) 100 m

6. A particle begins to move with a tangential acceleration of constant magnitude 0.6 m/s^2 in a circular path. If it slips when its total acceleration becomes 1 m/s^2, then the angle through which it would have turned before it starts to slip is :

(A) 1/3 rad (B) 2/3 rad (C) 4/3 rad (D) 2 rad

7. One of the forces acting on a particle is conservative then which of the following statement(s) are true about this conservative force

(A) Its work is zero when the particle moves exactly once around any closed path.

(B) Its work equals the change in the kinetic energy of the particle

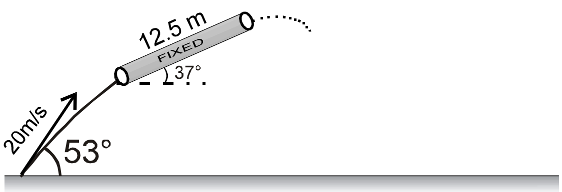
(C) Then that particular force must be constant.

(D) Its work depends on the end points of the motion, not on the path between.

COMPREHENSION

A particle of mass 0.1 kg is launched at an angle of 53° with the horizontal. The particle enters a fixed rough hollow tube whose length is slightly less than 12.5 m and which is inclined at an angle of 37° with the horizontal as shown in figure. It is known that the velocity of ball when it enters the tube is parallel to the axis of the tube. The coefficient of friction between the particle and tube inside the tube is $\mu = \frac{3}{8}$.

[Take g = 10 m/s^2]



8. The velocity of the particle as it enters the tube is :

(A) 12 m/s (B) 16m/s (C) 9 m/s (D) 15 m/s

9. The kinetic energy of the particle when it comes out of the tube is approximately equal to :

(A) Zero (B) 4 J (C) 7.2 J (D) 11.2 J

10. The distance from the point of projection where the particle will land on the horizontal plane after coming out from the tube is approximately equal to :

(A) 8.4 m (B) 10 m (C) 18.4 m (D) 36.8 m

Answers Key

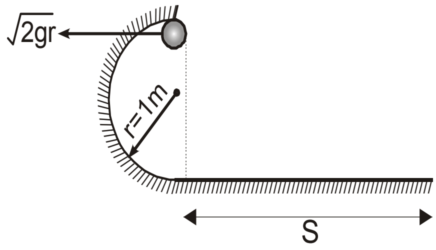
DPP NO. - 41

1. (C) **2.** (D) **3.** (B)
4. (A) **5.** (B) **6.** (B)
7. (A), (D) **8.** (D) **9.** (A)
10. (C)

Hint & Solutions

DPP NO. - 41

1.



By work energy theorem

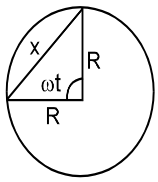
$W_g + W_f = K_f - K_i$

$\Rightarrow$ mg 2r – μmgS = 0 – $\frac{1}{2}$ m (2gr)

$\Rightarrow$ 3mgr = μmgS

$\Rightarrow$ S = $\frac{3r}{\mu}$ = $\frac{3 \times 1}{0.5}$ = 6m

2.



$\cos \omega t = \frac{R^2 + R^2 - x^2}{2R^2}$

$\therefore$ x = 2R sin $\frac{\omega t}{2}$

3. The ratio of distance travelled by B and C in same duration of time t is = $v_B : v_C$ = 5 : 4

4. $\frac{2\pi r_1}{v_1} = \frac{2\pi r_2}{v_2} \Rightarrow \frac{v_1}{v_2} = \frac{r_1}{r_2} = \frac{1}{2}$

$\frac{v_1^2 / r_1}{v_2^2 / r_2} = \left(\frac{v_1}{v_2}\right)^2 . \left(\frac{r_2}{r_1}\right) = \frac{1}{4} . 2 = \frac{1}{2}$

Alternate method $\frac{a_1}{a_2} = \frac{\omega^2 r_1}{\omega^2 r_2} = \frac{r_1}{r_2} = \frac{4}{8} = \frac{1}{2}$

5. Mathod (I)

After 3 sec.

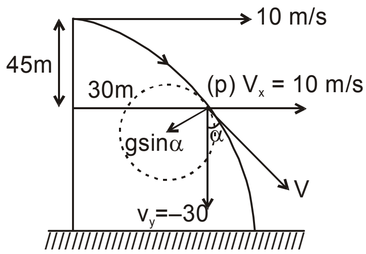
$V_y = u_y + gt = -30$ m/s

and $V_x = 10$ m/s $\quad \therefore V^2 = V_x^2 + V_y^2$

$\Rightarrow \quad V = 10\sqrt{10}$ m/s

Now, $\tan\alpha = \dfrac{V_x}{V_y} = \dfrac{1}{3}$

$\Rightarrow \sin\alpha = \dfrac{1}{\sqrt{10}}$



Radius of curvature $r = \dfrac{V_\perp^2}{g\sin\alpha}$

$r = 100\sqrt{10}$ m

Mathod (II)

Let horizontal and vertical position of point p be x & y respectively

$\therefore \quad x = Vt$ and $y = \dfrac{1}{2}gt^2$

$\therefore \quad$ equation of trajectory $y = \dfrac{gx^2}{2V^2}$

$\therefore \quad \dfrac{dy}{dx} = \dfrac{gx}{V^2}$ and $\dfrac{d^2y}{dx^2} = \dfrac{g}{V^2}$

Radius of curvature $r = \dfrac{\left\{1+\left(\dfrac{dy}{dx}\right)^2\right\}^{3/2}}{\dfrac{d^2y}{dx^2}}$

$= \dfrac{\left(1+\dfrac{g^2x^2}{V^4}\right)^{3/2}}{g/v^2}$

Now after 3 s $\quad x = Vt = 30$ m

and $\quad V = 10$ m/s

$\therefore \quad r = 100\sqrt{10}$ m.

6. $a_{Net} = \sqrt{a_t^2 + a_c^2}$

$\omega^2 = \omega_0^2 + 2\alpha\theta$

$\because \omega_0 = 0$

so $\omega^2 = 2\alpha\theta$

$\omega^2 R = 2(\alpha R\theta)$

$a_c = \omega^2 R = 2a_t\theta$

$1 = \sqrt{0.36 + (1.2 \times \theta)^2}$

$\Rightarrow \quad 1 - 0.36 = (1.2\,\theta)^2$

$\Rightarrow \quad \frac{0.8}{1.2} = \theta$

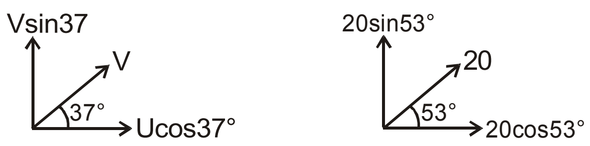
$\Rightarrow \quad \theta = \frac{2}{3}$ radian

7. Only the following statements are true from definition of a conservative force.

"Its work is zero when the particle moves exactly once around any closed path".

"Its work depends on the end points of the motion, not on the path between".

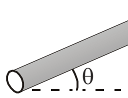
8. The particle while entering has inclination of 37° . Let its velocity here be V.



Now V cos 37° = 20 cos53° as horizontal component does not charge.

$\therefore$ V = 20 × $\frac{3}{5} \times \frac{5}{4}$ = 15 m/s.

9. The initial velocity is 15 m/s acceleration of particle is ($g \sin\theta + \mu g \cos\theta$)
downwards along the tube.



$$\therefore\ a = 10 \sin 37 + \frac{3}{8} \times 10 \times \cos 37 = 10 \times \frac{3}{5}$$

$$+ \frac{3}{8} \times 10 \times \frac{4}{5} = 9 \text{ m/s}^2$$

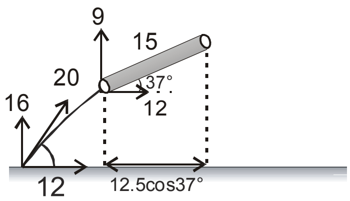
$\therefore\ V^2 = u^2 + 2as$

$V^2 = 15^2 - 2 \times 9 \times 12.5 = 0$

$\therefore\ V^2 = 0$

Given that the tube is slightly less than 12.5 m. It means the particle will just drop from tube. Hence K.E. at the tube end = 0.

10. Time taken by projectile to reach the bottom of tube from point of projection is



$$9 = 16 - gt \ \therefore\ t = \frac{7}{10} = 0.7 \text{ sec.}$$

During this time particle travels 12×0.7 m
= 8.4 m horizontally.

$\therefore$ Total distance = 8.4 m + 12.5 cos37°
= 8.4 + 10 = 18.4 m.